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DURABILITY OF HIGH-STABILITY ASPHALT MIXTURE UNDER AIRCRAFT LOADING

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Introduction

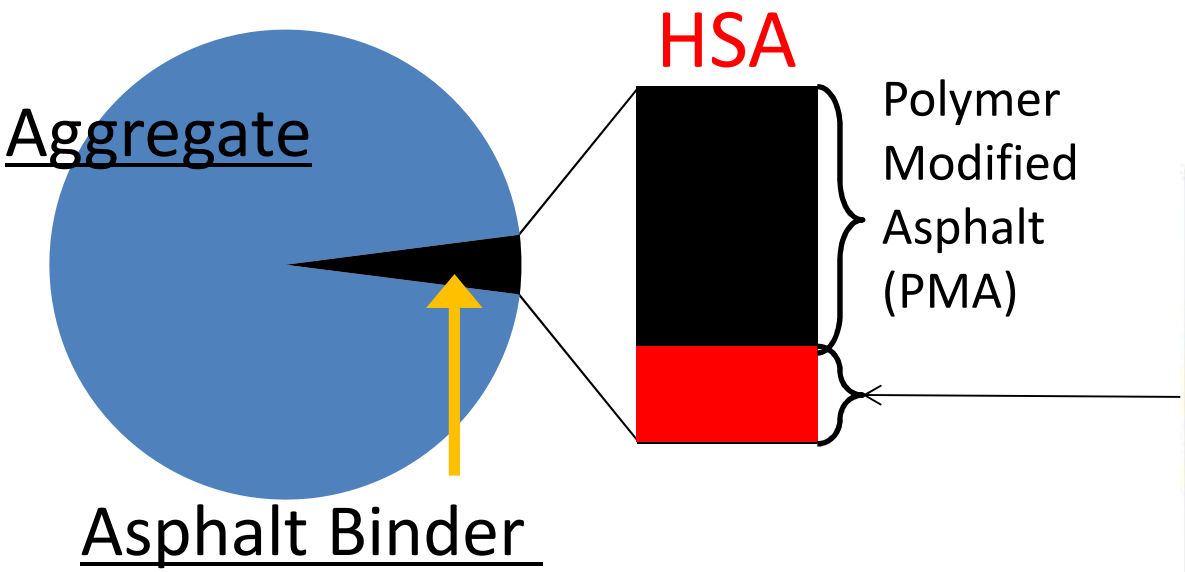
Most runways and taxiways in Japan are paved with asphalt mixtures.

Cementitious materials are rarely used because of overnight serviceability is required.

Development of materials that have a higher rutting resistance and the serviceability is a technical challenge.

High-Stability Asphalt（HSA）

Composition of HSA mixture



Special thermoplastic resin

Addition of special thermoplastic resin can drastically improve resistance to rutting and oil of hot-mix asphalt

HSA mixture

The HSA mixture is a promising material to reduce rutting in airfield.

Purpose of the study

Before applying the mixture to airfield, it is important to clarify the durability of the HSA mixture under aircraft loadings.

HSA pavement in road

https://www.toadoro.co.jp/business/product/1/

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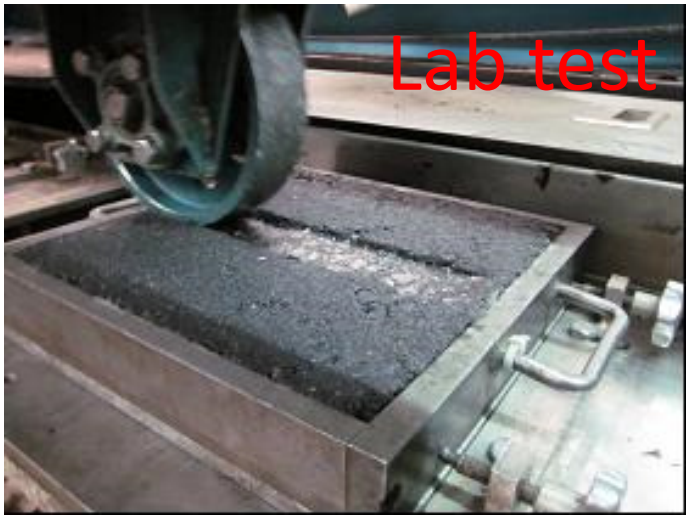
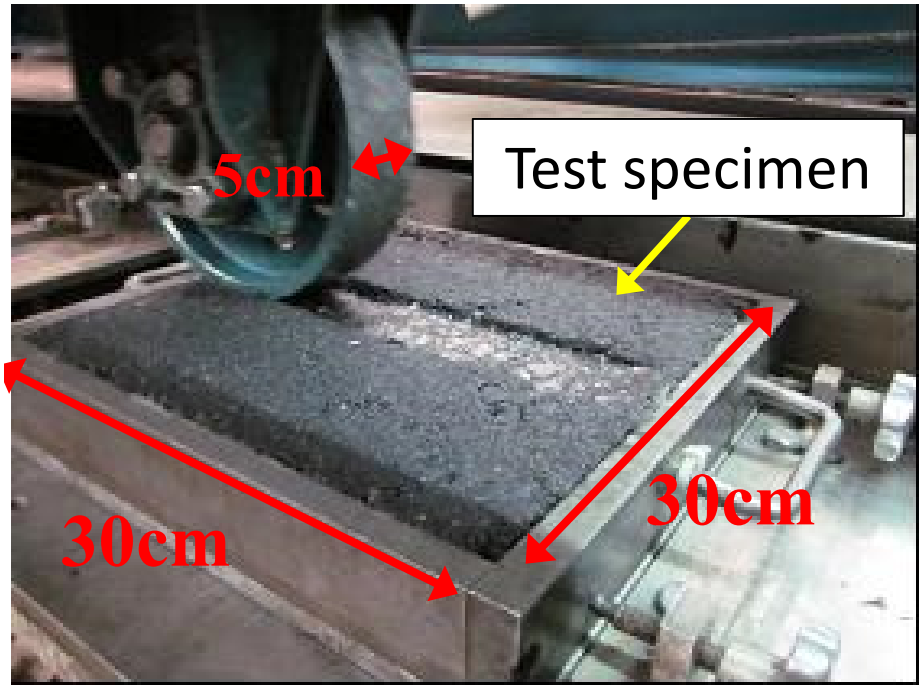


Rutting resistance

Rutting resistance was evaluated by means of a Japan Wheel Tracking (WT) device.

WT test device



- Test temperature : 60℃
- Load: 1715N

  Simulative loading of an aircraft
- Wheel speed: 42 passes/min at center point
- Index: Permanent deformation in the vertical direction after 60 minutes

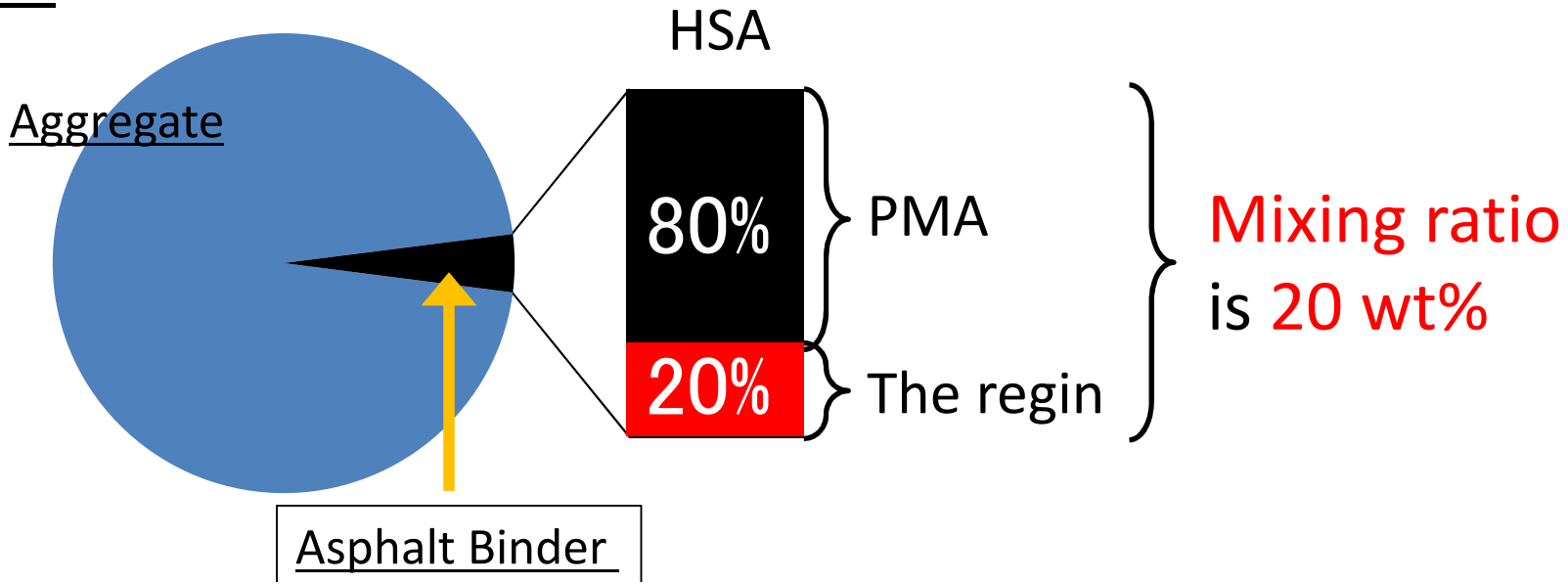
Materials

The HSA mixtures with various resin mixing ratios were tested.

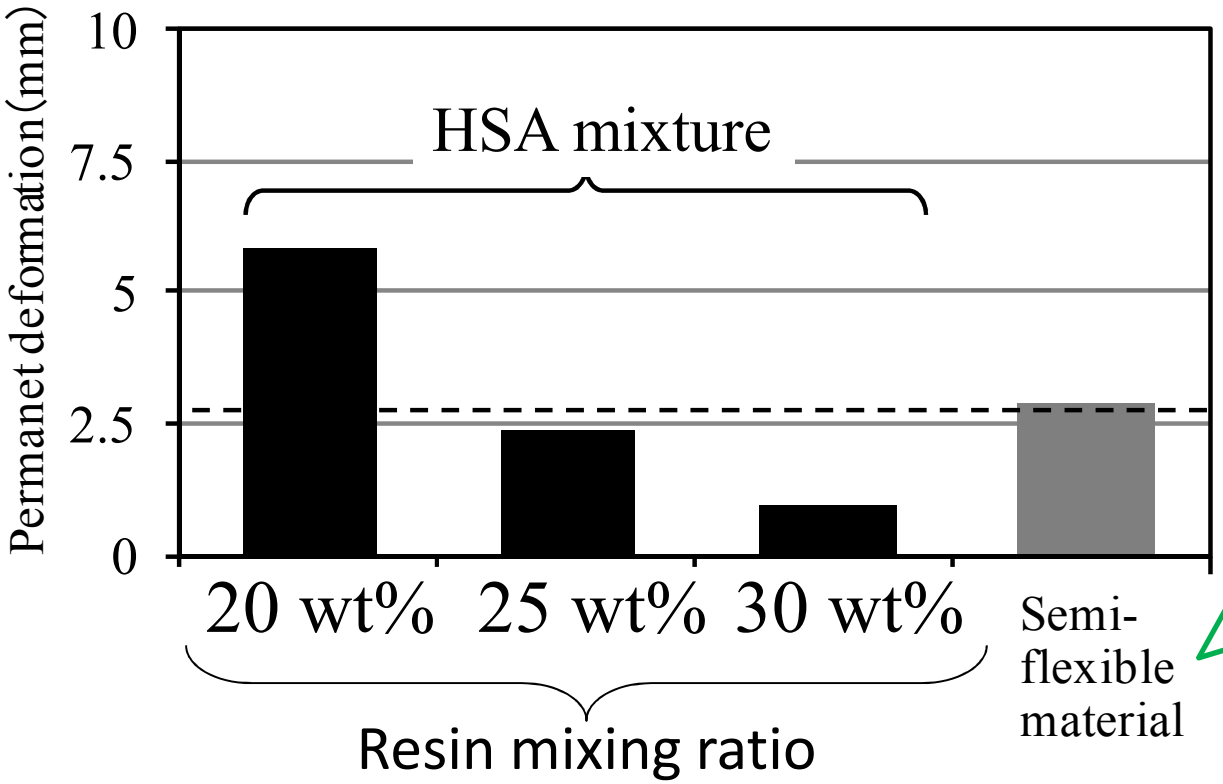
Resin mixing ratio was designed to be 20, 25, 30wt% of the asphalt content

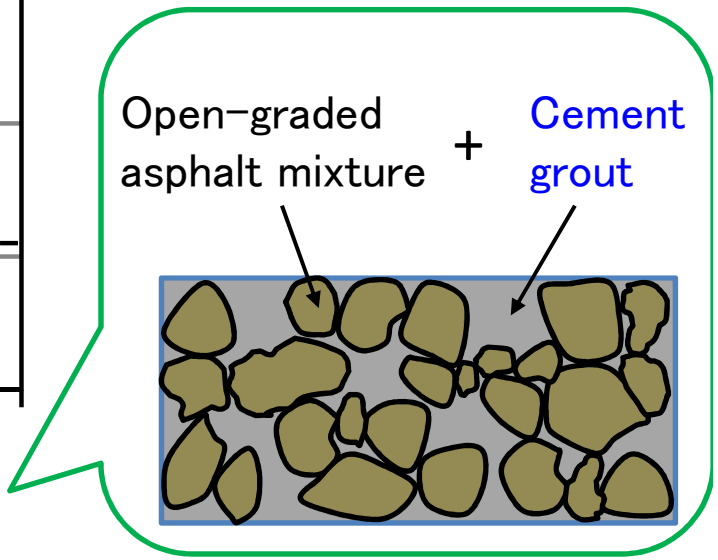
↑ Mixing ratio for road pavement

e.x.



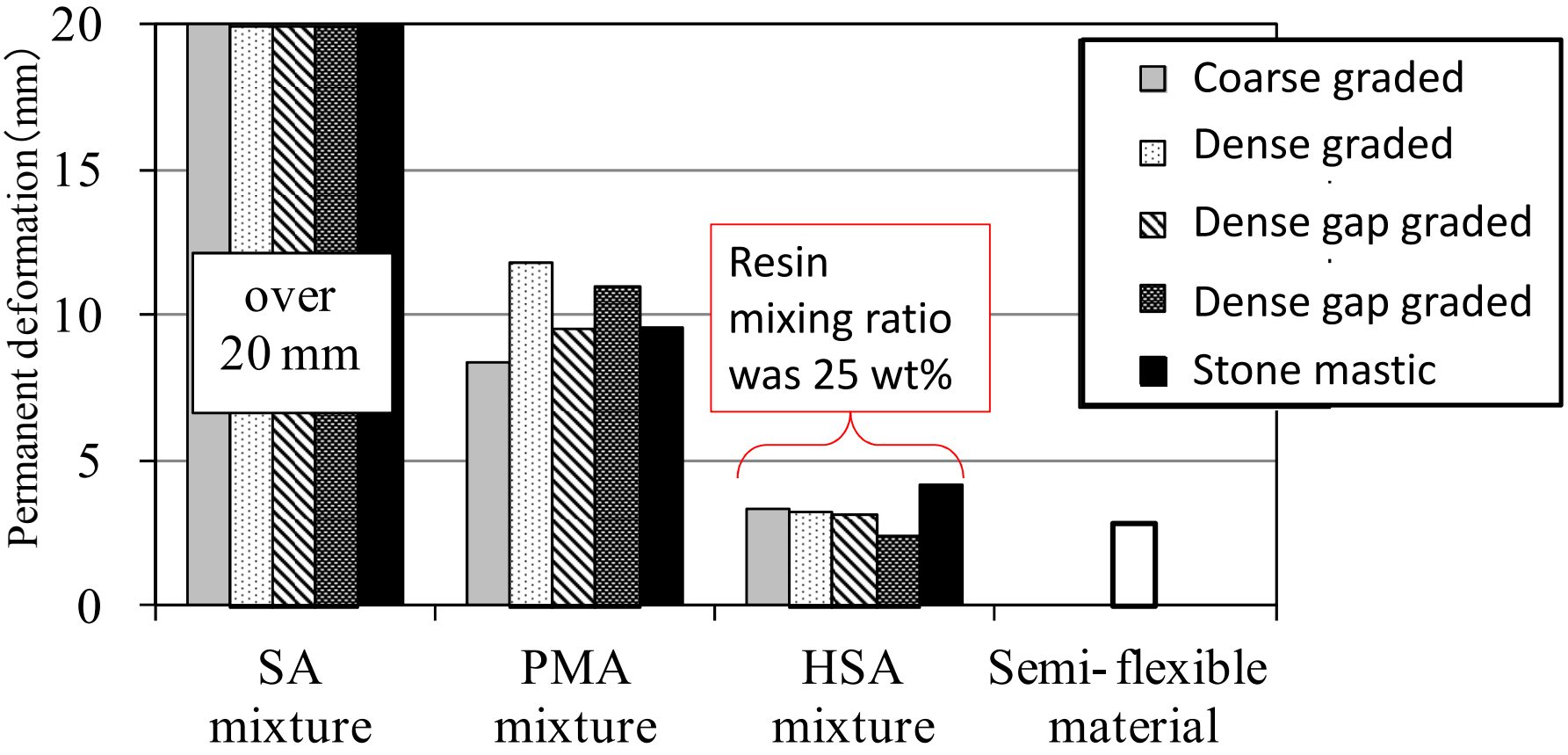
Permanent deformation for various resin mixing ratio





Rutting resistance of the HSA mixture whose resin content of **25 wt%** can be equivalent to that of a semi-flexible material.

Comparison with conventional materials



The permanent deformation of the HSA mixture was about one-third that of the PMA mixture and at least one-fifth that of the SA mixture

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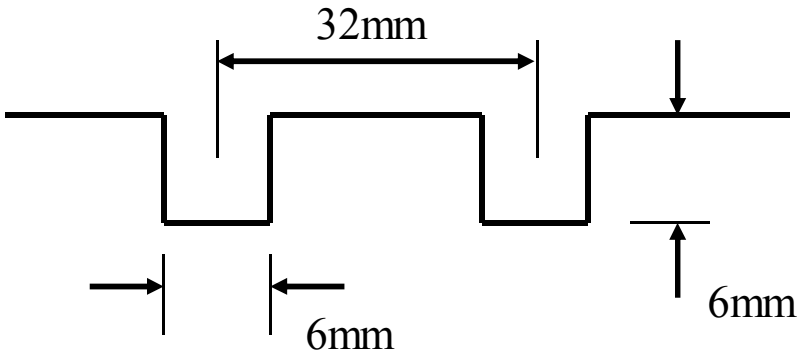
WT test

Test specimen whose surface was grooved transversely

Cross section of the grooves

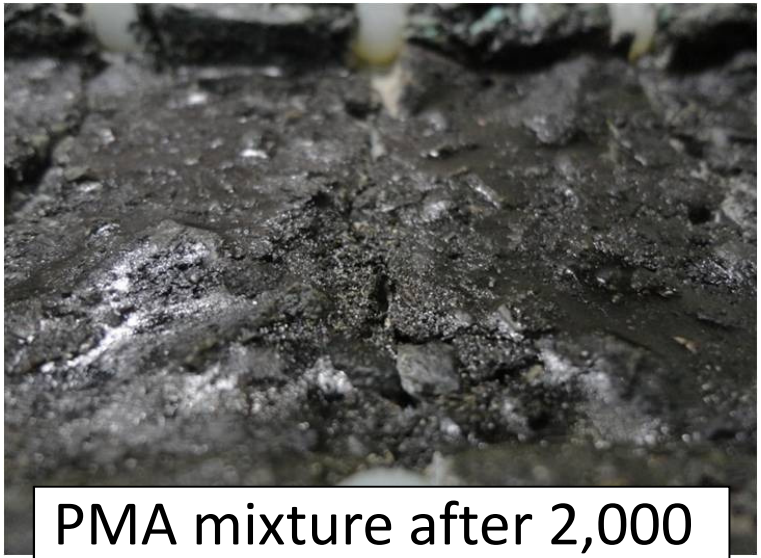


- Test temperature : 60℃
- Load: 1.48MPa (Contact tire pressure of large aircraft)
- The maximum number of wheel passes: 2000
- Test materials: SA, PMA, HSA mixture.
  (Each mixture was dense graded mixture)

Change in the shapes of grooves

Before WT test

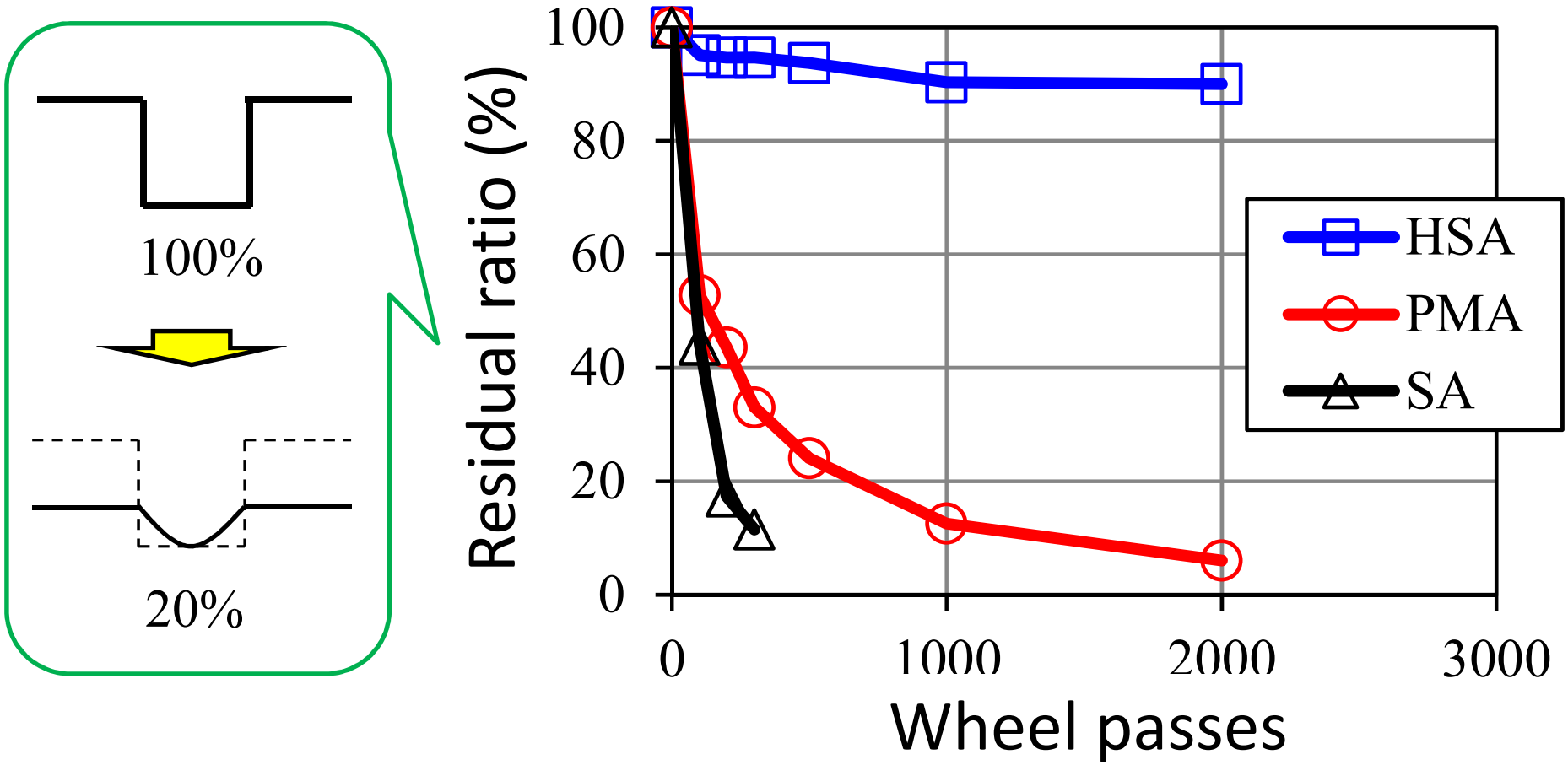
SA mixture after 500 wheel passes



PMA mixture after 2,000 wheel passes

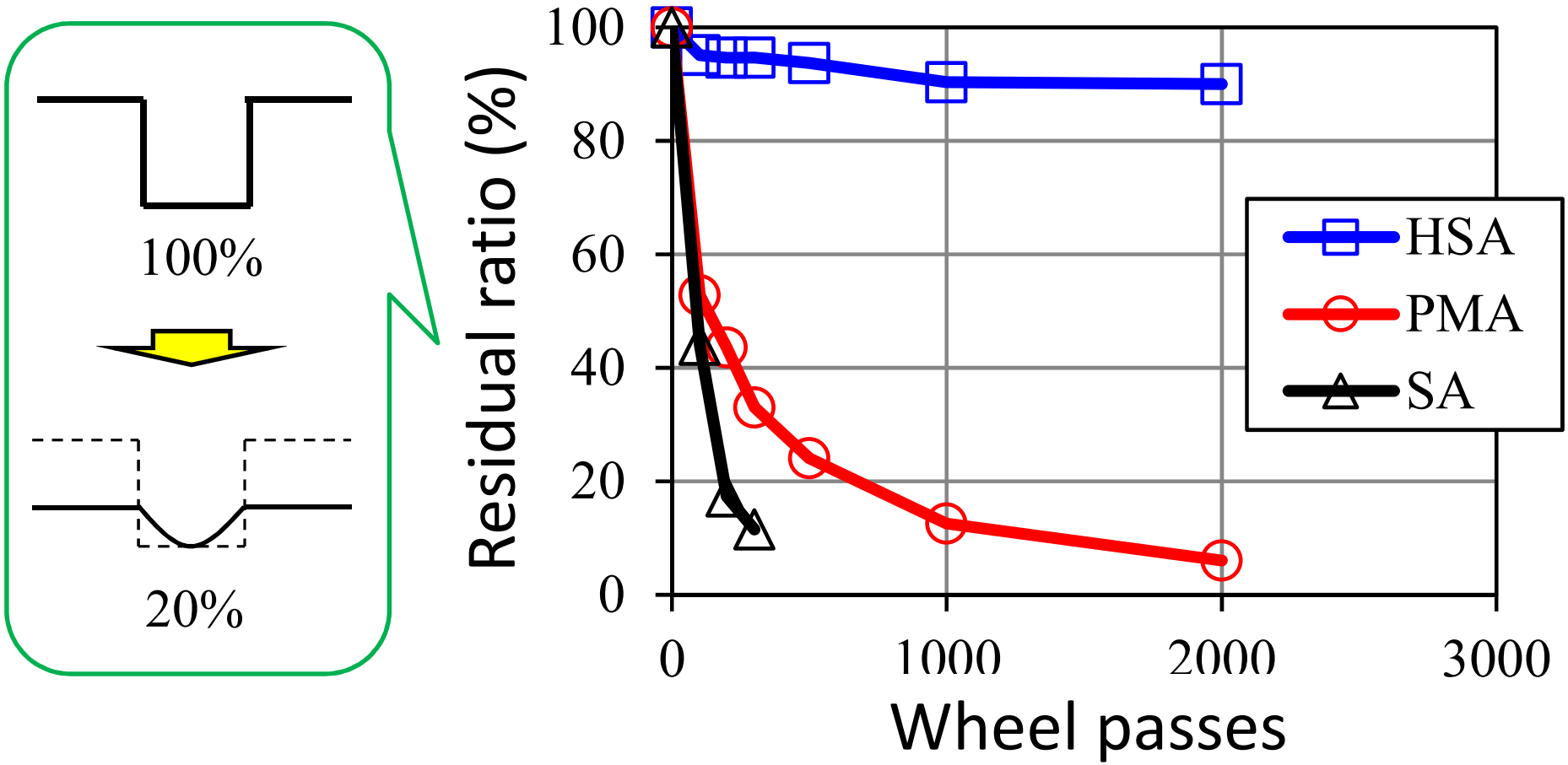
HSA mixture after 2,000 wheel passes

Residual ratio for the groove volume vs. number of wheel passes



Residual ratio is the ratio of the groove volume after a certain number of wheel passes to the groove volume before test.

Residual ratio for the groove volume vs. number of wheel passes



The residual ratio of the HSA mixture was about ten times higher than that of the PMA mixture.

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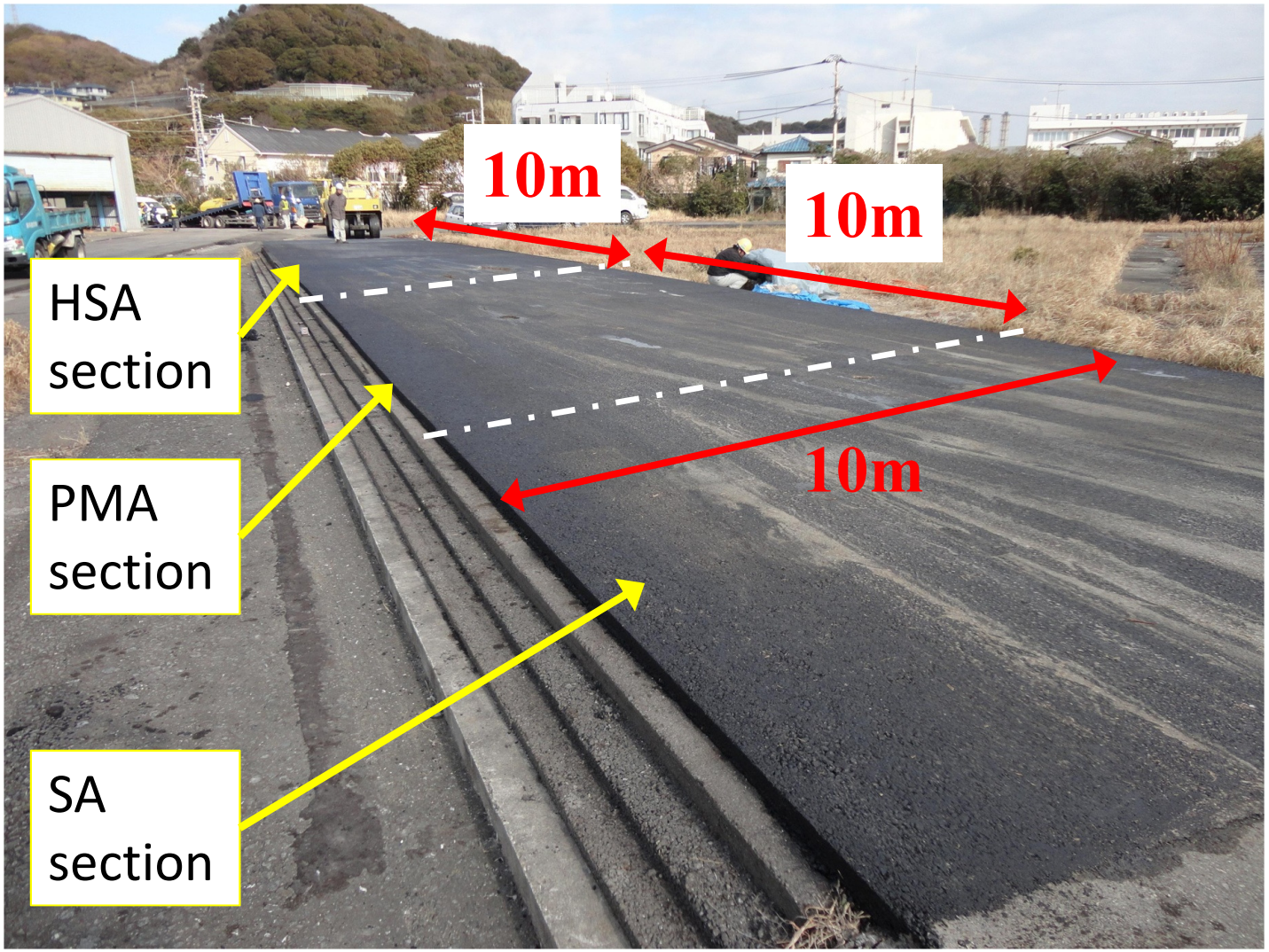
Test pavement (Before groove)

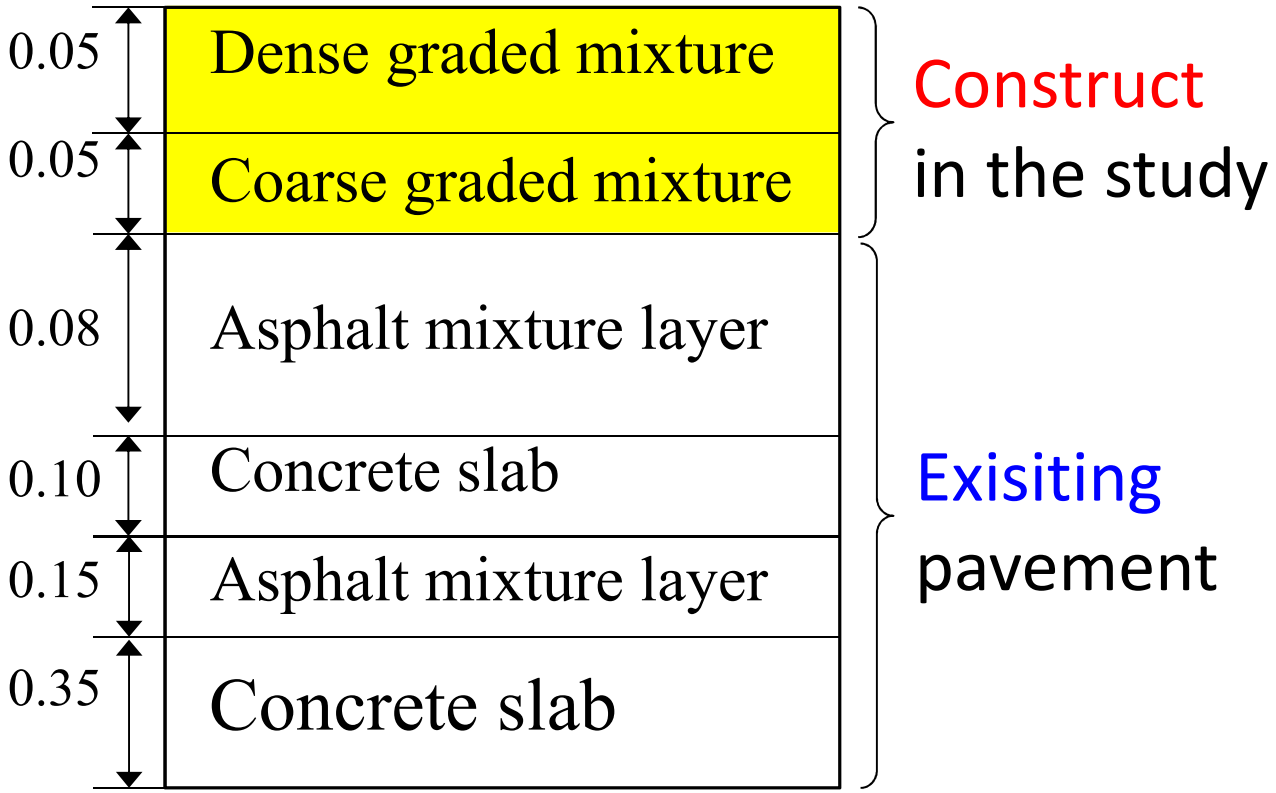


Grooves were partly cut into the surface of each section.

Test pavement

(Unit: m)

【Cross-section】



In HSA section, the mixing ratio of the resin was design to be 25 wt% of the asphalt content of the HSA mixture

Repeated loading test

Loading vehicle

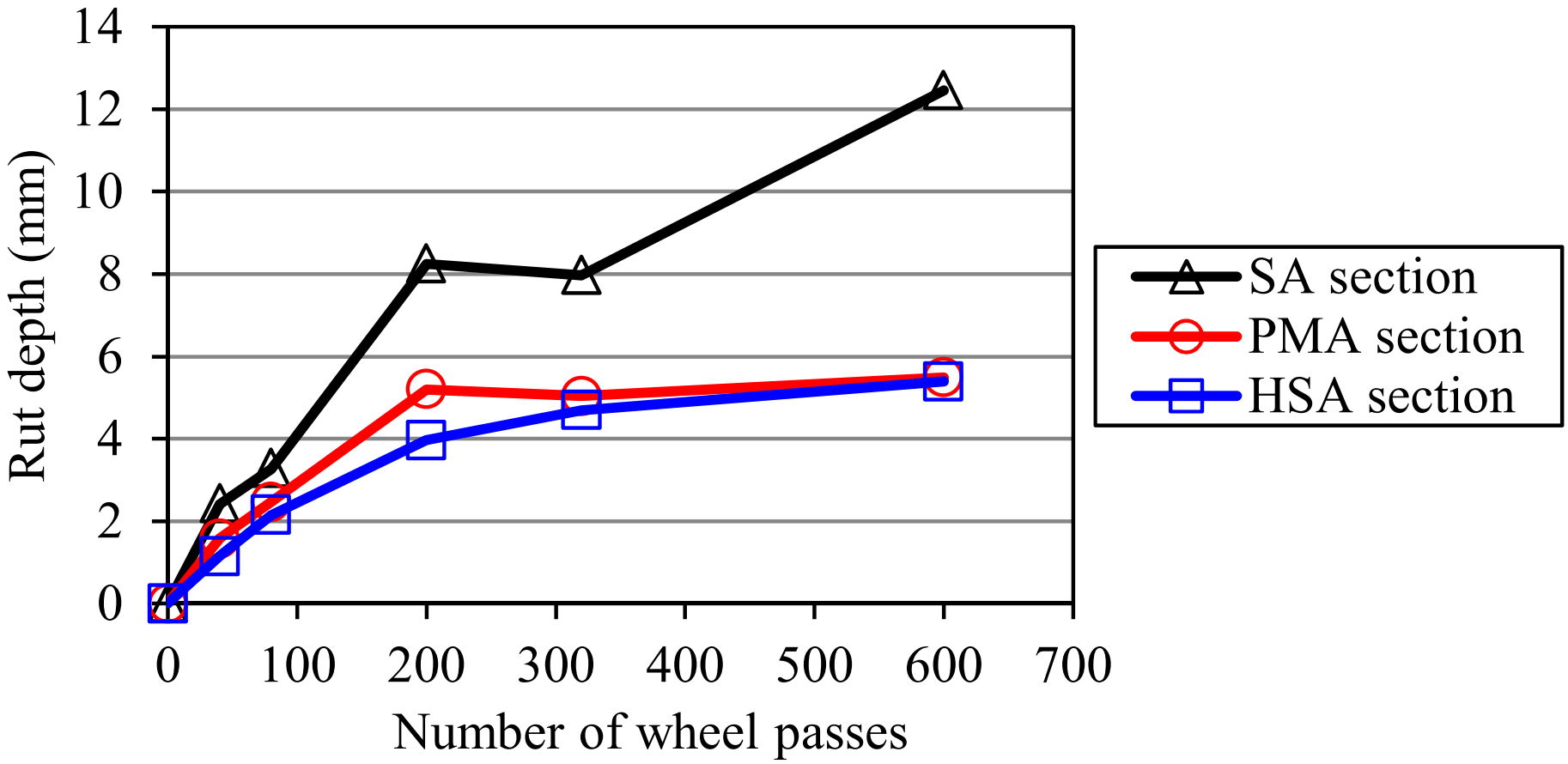
Loading wheels
(main gear of a B747)

Repeated loads of 934kN was applied to test pavement

Number of wheel passes: 600

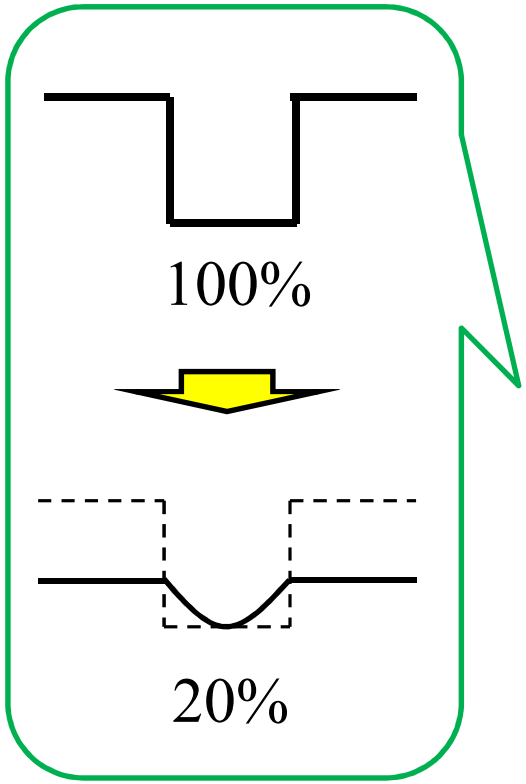
Maximum surface road temperature: 41 ^{o}C

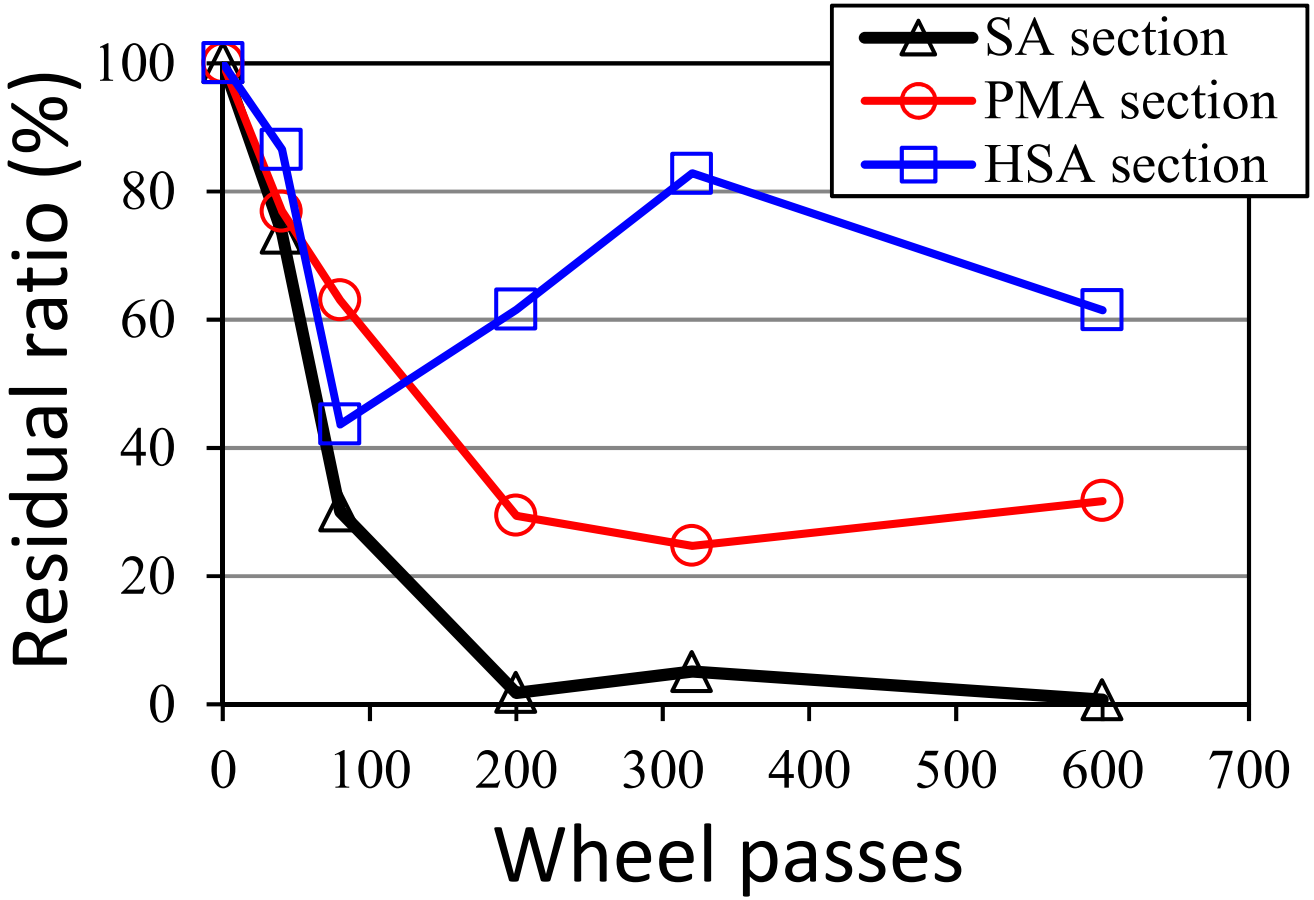
Rut depth vs. number of wheel passes



In laboratory tests, rutting resistance of the HSA mixture was highest. However, there was little difference in the rut depth between the PMA section and the HSA section

Residual ratio of groove volume vs. number of wheel passes





The superior groove stability of the HSA mixture was confirmed in the full-scale loading test

Conclusion

1) In the WT tests, permanent deformation of the HSA mixture whose resin content was 25 wt%, could be reduced by one-third compared to that of the PMA mixture under heavy loading.

2) In the WT tests, the residual ratio of the HSA mixture was about ten times higher than that of the PMA mixture.

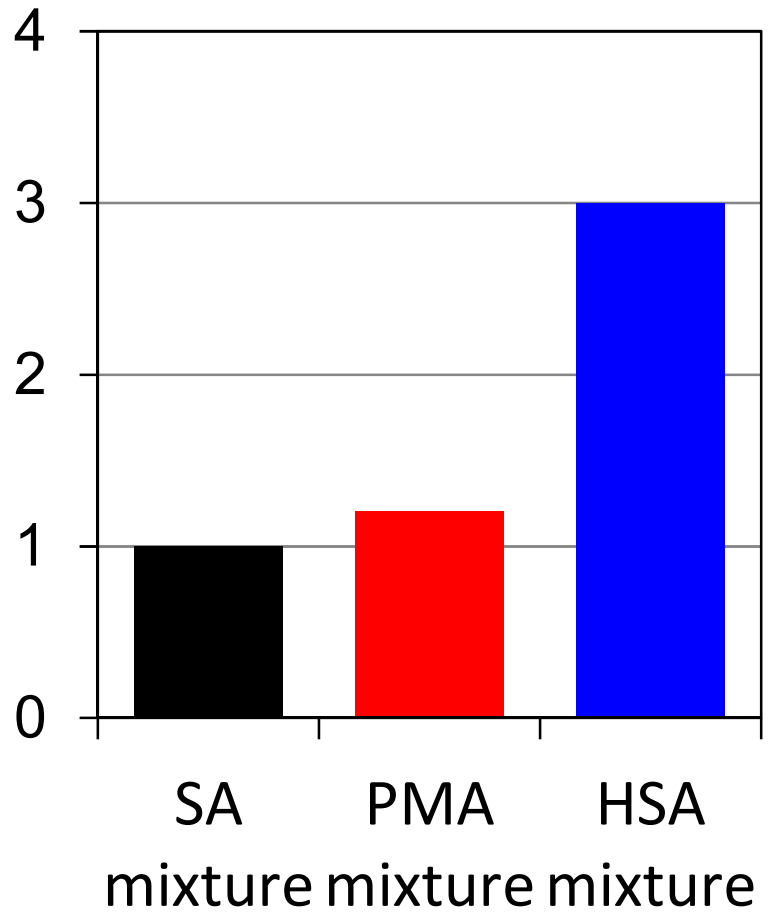
3) In field test, the superior groove stability for the HSA mixture was confirmed. However, there was little difference in the rutting resistance between the HSA mixture and the PMA mixture

Applicability of the HSA mixture

It might be effective to apply to runway end where grooves tend to early disappear.

However, it is necessary to analyze the cost-benefit of the HSA mixture in airfield.

Ratio of unit price to that of the SA mixture



Thank you very much for your attention

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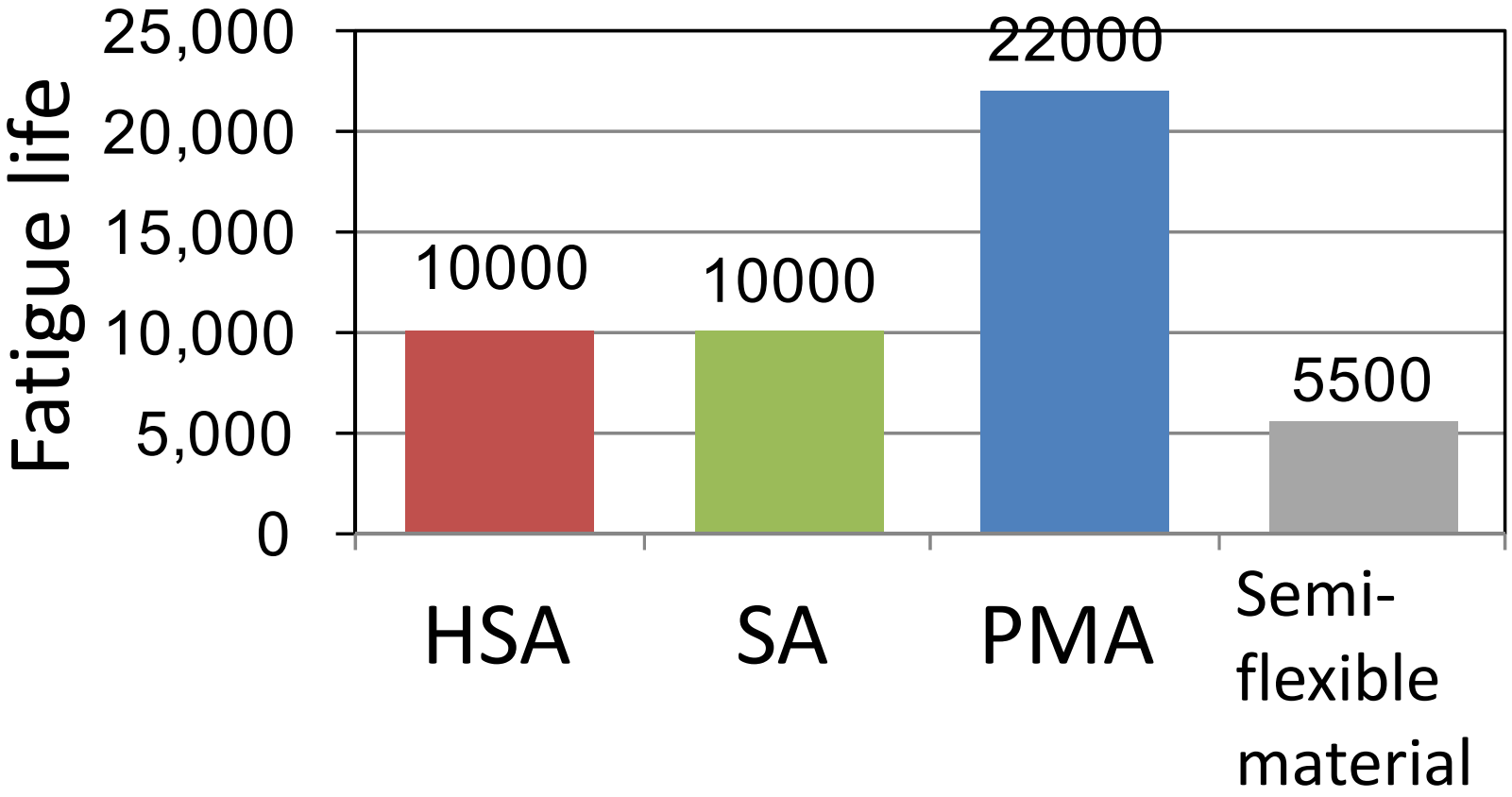
Grooving after the repeated loading test

PMA section

HSA section

In the HSA section, the aggregates at the groove edge were chipped off significantly during the test.

Results of bending fatigue test

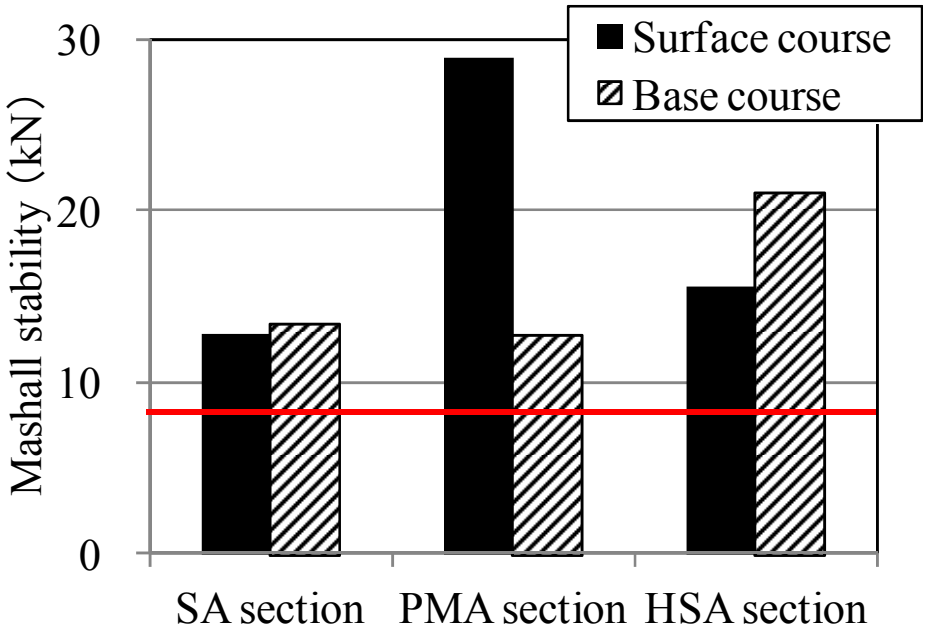


Fatigue resistance of the HSA was equal to be that of the SA mixture

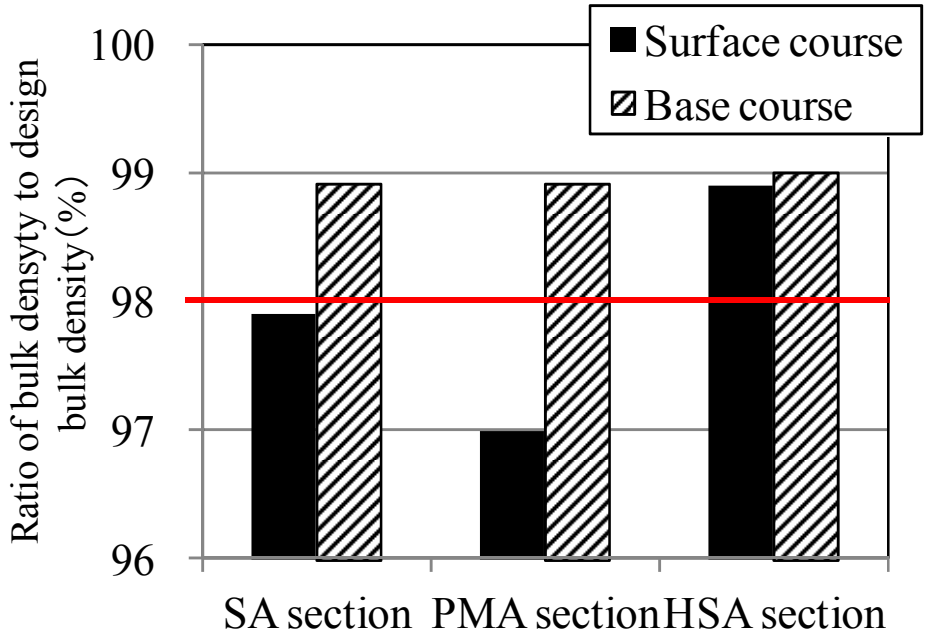
Marshall stability and bulk density of test pavement

Cylindrical cores were sampled from the pavement.

Marshall stability



Ratio of bulk density to design bulk density



The HSA mixture, which has a resin content of 25 wt%, satisfies the specification of the Japan Civil Aviation Bureau.

HSA mixture

The HSA mixture can be applied using the same construction procedure used for conventional hot-mix asphalt

Mixing and compaction temperatures of the HSA mixture

Recommended temperature (°C)	Straight Asphalt (SA) mixture	Polymer modified asphalt (PMA) mixture	HSA miture
Mixing	150～165	165～180	170～185
Placement	145～155	155～170	160～175
Initial compaction	140～150	150～170	150～170
Secondary compaction	110～130	120～140	120～140

Slightly higher than the PMA mixture

Same temperature of the PMA mixture